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EFFECT OF WINTER FEEDING ON THE RATE OF GROWTH, FOOD CONVERSION AND SURVIVAL OF NILE TILAPIA (*OREOCHROMIS NILOTICUS* L.) AND COMMON CARP (*CYPRINUS CARPIO* L.) IN EGYPT

A.E. ABD EL-GHANY

Central Laboratory for Fish Research, Agricultural Resaerch Centre, Giza, Egypt.

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Abstract

The study demonstrated positive benefits of winter feeding. Fish without feeding in winter lost significant by ($P < 0.05$) body weight. Fish received feed at either 1% or 2% of body weight gained substantial weights. Fish demonstrated poor food conversion rates (FCR) reduced growth rates, but with good survival rates. Fish producers addressing spring markets could increase weight gain and improve the FCR by adjusting overwinter feeding.

The routine metabolism was determined for both fish species. The mean values for the entire period of the experiment were 64.7 cal/fish/day for *Oreochromis niloticus*, and 247.5 cal/fish/day for *Cyprinus carpio*. The metabolic rate of a fish of 1g (The specific routine metabolism) was determined. The mean values were 4.92 cal/day and 11.87 cal/day for Nile Tilapia and common carp, respectively. The dietary metabolizable energy required for maintenance of a fish of 1g was determined. The mean values were 9.84 cal/day, and 23.74 cal/day for Nile Tilapia and common carp, respectively.

INTRODUCTION

Nile Tilapia and common crap are the most common fresh water fish species cultured in the world (Balarin 1979). They have fast growth, effcient use of natural foods, propensity to consume a variety of supplemental feeds, resistance to diseases, ease of reproduction in captivity and tolerance to wide ranges of environmental coditions (Huet 1972). They survive in water having 2 mg/L dissolved oxygen and can tolerate higher ammonia levels than can most fish (Logsdon 1978). The two species of fish are omnivorous, and in culture ponds they feed on a wide variety of plants and animal matter (Bardach *et al.* 1972).These characteristics enable them to compete favourably with other species, and they have top priority for culture, not only in Egypt but also all over the world. The period of the fish growing season in Egypt is 7 to 8 months from March or April to the end of october. This period is capable of rapid growth due to suitable temperatures (24-30°C), and to enhancement of water fertility by feed input. However, a longer time of growth is necessary for these fishes to reach larger sizes such as 400-500g. They must frequently be overwintered to produce larger fish for special markets or to address seasonal market (e.g. easter day) in which producers receive higher prices in April or May.

In Egypt, the majority of fish farmers do not feed fish during winter time where water temperature varies from 6°C-20°C.Although Egypt usually has a mild winter, fish farmers claim that fish do not eat or grow under the prevalent climatic conditions of winter. However, this has not been proved experimentally. Dupree and Huner (1984) reported that Tilapia becomes lethargic and stops feeding when temperature falls below 15.5°C. Chervinski (1982) reported that the activity and feeding Tilapia become reduced below 20°C and feeding stops around 16°C. Vostradovski (1978) reported that common carp stops feeding below 10°C. However, no study has been carried out on the growth and feed utilization of Nile Tilapia or common carp during winter time in Egypt.

The objective of the present study was to investigate the growth rate, FCR and feed utilization of Nile Tilapia and common carp feed at three different feeding rates of 2%, 1% and Zero% of body weight under the prevalent climatic condition during winter months of Egypt.

MATERIALS AND METHODS

Twelve 30 m^3 concrete ponds (12 m x 2 m x 1.25 m), with bottom drains at the end opposite the inflow were used in this study. The ponds were located at the Central Laboratory of Fish Research in Abbassa, Sharkia, Egypt. Water was pumped from a deep well with a constant supply of water allowed in daily replacement of about 25% of the pond's volume to avoid growth of phytoplankton or any other natural food. Each pond was continuously aerated via plastic hosing attached to a central compressor at the station. *O. niloticus* and *C. carpio* were stocked (each species in six of ponds) at rates of 250 fish/pond and 110 fish/pond, respectively. The two species of fish were fed a formulated diet containing approximately 30% protein at three different feeding rates of 2%, 1% and zero%. Therefore, each of the feeding levels was tested in two ponds (2 replicates per treatment). Fish samples were taken every two weeks and the mean weight of the fish in each pond at the end of the two weeks served for calculating the amount of feed for the next growth period. The proximate analysis of the diet and its components are shown in Table 1. The daily rations were divided into morning and afternoon feedings. Fish were fed six days a week. Samples of fish were taken at the beginning and at the end of the study for chemical analysis. The fish samples of the duplicates of each treatment were combined in a composite sample. The intact fish of each sample were minced together three times through a mincing machine, mixed well and a portion was taken as a subsample for the determination of moisture, protein, lipid and ash. the diet and fiesh were analysed by standard methods according to the Association of Official Analytical Chemists (AOAC 1980). Nitrogen contents were measured by macro-kjeldahl and crude protein was eastimated by multiplying nitrogen values by 6.25, lipid contents were established by the ether extract method. The calorific values of the fish were calculated using the gross calorific equivalents of 5.65 k cal/g protein, 9.45 kcal/g lipid and 4.1 kcal/g carbohydrate (Brett 1973 and Jobling 1983). Water quality parameters were monitored throughout the study. The mean values of dissolved oxygen, temperature, PH and total alkalinity for the entire period were 5.6 mg/L, 13.5°C, 7.6 and 150 mg/L, respectively. The study was started on Dec. 3rd., 1990 and continued for 100 days.

Mean values of gains, survival rate and nutrients deposited (protein, fat and gross energy) in fish tissuess for each treatment were compared using analysis of variance and Duncans' multiple range test (Duncan 1955).

RESULTS AND DISCUSSION

The results of the study showed the necessity of feeding fish during the prevalent climatic condition of winter in Egypt. Nile Tilapia and common carp receiving no feed lost substantial body weights at the end of the experiment (Table 2).

Nile Tilapia and common carp fed at either 1% or 2% of body weight gained significant ($P < 0.05$) weights and had higher growth rates (g/day) and survival rates comparing to the starved fish.

Feeding at the low level (1% of body weight) saved the loss of fish body weight or even resulted in some net weight gain.

Nile Tilapia and common carp fed at 2% of body weight had the highest weight gain per fish and mean daily growth . These were 19.80 g/fish and 16.15 g/fish, respectively, and 0.20 g/day and 0.16 g/day, respectively (Table 2). These results indicate the positive growth response of winter feeding for both fish species.

Fish demonstrated poor food conversion rate, this may be due to uneaten feed when occasionally water temperature severely dropped below the optimum. Therefore, it is recommended that feeding is reduced and administered on only warm days during winter months. The mean values of FCR were lower in *O. niloticus* than in those of *C. carpio,* and the values of apparent net potein utilization (App.-Npu) were higher in Nile Tilapia than in common carp, since FCR measurement expresses the efficiency of the conversion of food to fish tissues and since App. -Npu is the best ·elative measure of dietary protein utilization by an animal. These results may be terpreted by that Nile Tilapia utilized food more efficiently than common carp but act..ally the results of the two species cannot be compared because of their different sizes and should be independently evaluated for each fish species.

Abd El-Ghany (1986) reported growth rate of 0.62 g/fish/day for Nile Tilapia (3.2 g/fish) raised for 10 weeks at 28°C. Abel *et al.* (1984) reported growth rates from 0.6 to 2.0 g/fish/day for common carp (22.6 g/fish) raised for 85 days at 24°C. In the present winter study, the fish growth rates were reduced in Nile Tilapia and common carp growth 0.20 g/fish/day and 0.16 g/fish/day, respectively at feeding level of 2%, and grew 0.14 g/fish/day and 0.07 g/fish/day, respectively at feeding level of 1% of body weight (Table 2). The reduced growth rate at low temperature has been previously reported for Tilapia (Caulton 1982), and common carp (Goolish and Adelman 1984) and for other fish species as channel catfish (Lovell & Sirikul 1974 , Reagan & Robinetts 1978 Mims & Tidwell 1989) and paddle fish (Rosen and Hales 1981).

The results of fish analysis for the major constituents (protein, lipid, ash and moisture) at the beginning and the end of the experiment are given in Table 3. No considerable changes in the four constituents were found on body composition of the fish (*O. nilotica* and *C. carpio*) fed at either 1% or 2% levels.

The body composition of fish receiving no feed showed remarkable reduction in the percentages of lipid and protein with a concomitant increase in moisture and ash. Similar results were reported by Arunachala and Rauichaundra (1981) in a feeding rate experiments on freshwater catfish (Mystus vittatus). Lovell & Sirikul (1974) reported that nonefed channel catfish during cool weather had the lowest percentage of protein and highest percentages of fat in their carcasses comparing to those fed fish indicating that fasting channel catfish catabolized body protein for thier metabolic energy needs in preference to or with the same affinity as depot fat.

From the results of Table 3, the actual mass losses or gains of protein, lipid and gross energy have been calculated and the results are presented in Table 4. The starved fish lost substantial amounts of these constituents. They catabolized their body protein and fat to survive. Common carp had more pronounced losses as percentages in their bodies contents of protein, fat and gross energy than Nile Tilapia. However, relative to the initial bodies contents of these constituents, the loss of lipid was the highest, followed by protein (Table 4). Since lipid is much richer in energy than protein, so, it contributes the larger protein of the energy required by fish. Raising the feeding rate from 1% to 2% resulted in increase in the protein and fat deposited in fish tissues of both species which again demonstrates a positive benefit of winter feeding.

The values of the food conversion ratio, percent weight gain, percent fat deposited and percent gross energy deposited were significantlty different ($P < 0.05$) at the two feeding levels of 1% and 2% with common carp (Tables 2 and 4). On the other hand, the values of these measurements were not significantly different ($P > 0.05$) at the same two feeding levels with Nile Tilapia. These results indicate that feeding rate of 1% of body weight could be sufficient to provide the nutritional requirements needed for optimum growth of *O. niloticus* during winter, but not for *C. carpio* under the experimental conditions.

A number of conclusions from the data may be important to the study of nutrition of the *O. niloticus* and *C. carpio* at the fish sizes used in the present study.

Routine metabolism (Q_R)

Routine metabolism is the requirement of energy for maintenance and spontaneous activity when fish move freely but do not feed. It does not include therefore, energy requirements for food digestion and assimilation (SDA), nor does it take into account unutilized dietary energy lost during conversion into free energy (heat increment). Studies have shown that routine metabolism can be determined either by indirect calorimetry-measuring the amount of oxygen consumed by the fish or by the loss tissue energy, and that these two methods usually agree well (Brett 1973 Huisman 1976). The data can be used to determine the routine metabolism of the Nile Tilapia and common carp by the second method.

The routine metabolism as taken from (Table 5) for the entire period of the experiment was 64.7 cal/fish/day for Nile Tilapia and 247.5 cal/fish/day for common carp at the fish sizes used in the present study.

Metabolism depends to a large extent on fish body weight. In order to compare ıetabolic rates of fish having different body weights, a common weight denominator ı. 'st be applied. This is done by using the exponent of the regression expressing the rela.'onship between metabolism (Q) and weight (W) which, according to Winberg (1956) is $Q=a\ W^{o.8}$.

The regression coefficient o.8 has been confirmed by many authors (Fry 1957, Paloheimo and Dickie 1966, Kausch 1968, and generally accepted as common to most fish species. However, the Y-intercept of the above regression, a , which expresses the metabolic rate of a fish of 1 unit weight (usually 1g) and therefore, may be called "specific metabolism - [Q]" (Hepher *et al.* 1983) or relative metabolism (Winberg 1956), varies among species. It also depends on environmental conditions and on the level of metabolism (standard, routine, maintenance or active metabolism). In similar environmental conditions and metabolic level, the specific metabolism, therefore, may be used for comparing the metabolic rates of different species.

In order to calculate the cpecific routine metabolism [Qr] in the present experiment, the values given above for the whole fish were divided by the 0.8 power of the average weights of fish during the experiment "metabolic weight" and the results are presented in Table 5 .

From the results of Table 5 it appears that common carp had a higher specific routine metabolism [Qr], than Nile Tilapia. This indicates that the metabolism of *O. niloticus* is more efficient than that of *C. carpio* under the experimental conditions tested. It also may indicate the lower nutritional requirements for body maintenance in O. niloticus than that needed for C. carpio during winter.

Food utilization for Growth

Brody (1945) and Warren and Davis (1967) have defined the partial efficiency of food utilization for growth (PEFG) as :

$$\text{PEFG} = \frac{\text{Energy deposited in body tissues}}{\text{Metabolizable energy of food - maintenance energy requirment}}$$

The value of PEFG is based on metabolizable energy of the food consumed and the dietary metabolizable energy required for maintenance of a fish.

In the present study the data for calculating this value can be obtained from the treatments where fish have received food at 1% or 2% levels as appearing in Table 6. The value of efficiency of utilization is calculated from the dietary energy. If the metabolizable energy is considered, the losses due to undigestible waste and metabolic excretion should be taken into account. Niimi and Beamish (1974) eastimated a coefficient value of 0.75 to convert the dietary gross energy to metabolizable energy based on average digestibility coefficients collected from the literature. By applying the coefficient of 0.75 to convert gross energy to metabolizable energy, the partial efficiency of food utilization for growth (PEFG) is obtained which is based on metabolizable energy.

The partial efficiency of food utilization for maintenance as defined by Brody (1945) and Davis and Warren (1968) is the product value of the amount of tissue energy loss saved by feeding divided by the amount of dietary energy consumed. This value was estimated as about 50% for several fish species such as common

Table 1. Composition and calorific contents of diet used in the experiment (in % of air-day weight).

Ingredients	Percentages
Fish meal *	40.97
Wheat bran	53.21
Corn oil	3.00
Starch	1.00
Vitamin Mixture. **	1.00
Mineral Mixture. ***	1.00
Analyzed Component	12.73
Moisture	29.95
Protein	8.15
Lipid	33.42
Carbohydrate ++	15.75
Ash	
Calculated gross calorific Value (Kcal / g)	3.83

* Commercial preparation approxim 53.20% protein, 7.17% fat and 29.92% ash.

** Vitamin mixture contained (as g/kg): Thiamine 2.5; Riboflavin 2.5; pyridoxine 2.0; Inositol 100.0; Biotin 0.30; Choline 200.0; Nicotinic acid 10.0; Cyanocobalamin 0.005.; &- tocopherol acetate 20.1; Ascorbic acid 50.0; Menadione 2.0; Retinol palmitate 100.000 IU ; choleoalciferol 500.000 IU.

*** Mineral premixes (as g/kg of premix): CaHpo4 7H20 727.7775; Mgso4. 7H20 127.5; Kcl 50.0; Nacl 60.0; FeSo4. 7 H20 250.0; ZnSo4 7 H20 5.5; MnSo4. 4H20 2.53; CuSo4 . 5H20 0.785; CoSo4 . 7H20 0.4775; Calo3. 6H20. 0.295; Crc3 6H20 0.1275.

The supplements of vitamins and minerals were originallyy formulated for trout (Tacon et al., 1982) but has proven successful with tilapias (Jauncey and Ross, 1982).

++ Calculated by difference.

Table 2. The effect of feeding rates on the growth rate, weight gain, food conversion ratio, apparent protein utitization and survival rate of Nile tilapia and common carp.

Feeding rate (% wt./day)	Initial weight (g) / fish	Final weight (g) / fish	Weight gain (g)/fish	% weight gain or loss *	Growth rate (g/day)	% Survival	FCR	App-NPU
Nile Tilapia								
0 %	25.76 A	24.27 C	-1.49 C	-5.78 B	-0.01 C	87 B	--	--
1 %	25.90 A	39.94 B	14.04 B	54.21 A	0.14 B	94 A	2.27 A	24.10 A
2%	26.28 A	46.08 A	19.80 A	75.21 A	0.20 A	92 A	3.60 A	16.85 A
Common Carp								
0 %	54.11 A	35.00 C	-19.11 C	-35.11 C	93.6 B	93.6 B	--	--
1 %	54.11 A	61.09 B	13.68 B	13.68 B	98.2 A	98.2 A	6.96 B	8.0 A
2%	54.08 A	70.23 A	16.15 A	29.87 A	99.1 A	99.1 A	9.69 A	3.45 A

Treatment means with some superscripts in the same columns are not significantly different at (P>0.05)

Table 3. Major constituents of fish tissue at the beginning and the end of the experiment (% wet weight).

			% Composition			
			Moisture	Protein	Lipid	Ash
Nile Tilapi	Initial		73.9	16.47	3.37	6.16
	Final	0 %	75.7	14.53	2.77	6.85
		1%	73.5	16.11	3.39	6.65
		2 %	73.4	16.55	3.70	6.00
Common Carp	Initial		77.7	14.56	2.65	4.86
	Final	0 %	78.0	13.44	2.05	6.23
		1%	77.3	14.1	2.93	5.43
		2 %	77.1	14.72	3.02	5.11

Table 4. The effect of feeding rate on the ıutriants (Protein, FAT, energy) Losses or gains in tissue on Nile tilapia and common carp.

Nutrients losses or gein	Nile Tilapia			Common Carp		
	2%	1%	0%	2%	1%	0%
Protein deposited (g/fish)	3.30 A	2.16 A	-0.79 B	2.45 A	0.84 A	-3.16 B
% Protein deposited	76.3 A	50.59 A	-18.72 B	31.16 A	10.62 A	-40.10
FAT deposited (g/fish)	0.81 A	0.48 A	-0.22 B	0.68 A	0.38 B	-0.72 C
% FAT deposited	89.99 A	54.24 A	-19.54 B	47.55 A	26.23 B	-50.19 C
GE deposited (Kcal / fish)	26.80 A	17.17 A	-6.47B	19.92 A	8.35 B	-24.75 C
% GE deposited	81.36 A	52.82 A	-20.01 B	34.05 A	14.27 B	-42.27 C

Treatment means with some superscripts in the same columns are not significantly different at $(P>0.05)$

Table 5. The specific routine metabolism of Nile tilapia and Common carp during winter months.

Fish species	Metabolic weight	Routine metabolism cal/ fish/ day	Specific Routine Metabolism Cal/ 1g of Fish per day
Nile Tilapi	25.02	-64.70	$64.7/ (25.02)^{0.8} = 4.92$
Common Carp	44.56	-247.50	$647.5/ (44.56)^{0.8} = 11.87$

Table 6. Calculation of partial efficiency of feed utiliaation for growth (PEFG) from metabolizable energy for Nile tilapia and common carp fed at feeding rates of 1% or 2% of body weight per day.

	Nile	Tilapia	Common	Nile
	1%	2%	1%	2%
Amount of food consumed (g/fish/day)	0.247	0.652	0.441	0.793
Gross energy of food consumed (Ca/fish/day) (1)	946	2152	1689	3726
Metabolizable energy of food consumed (2) (Calfed / fish / day)	710	1614	1267	2795
Average fish weight (Metabolic fish weight) (3)	32.92	36.18	57.89	62.16
Energy gain (cal / fish / day)	172	268	84	199
Maintenance requirement of energy (4) For fish (cal / fish / day)	161	147	147	646
Partial efficency of food utilization for growth (PEFG)	0.313	0.186	0.128	0.093

1- 3830 cal / g feed.
2- Gross energy x 0.75.
3- (Inilital weight + Final weight) 2
4- (9.84 cal / day for Nile tilapia and 23.74 cal / day for comman carp) multiplied by the appropriate WO.8.

carp (Kausch 1968), Largemouth bass (Niimi and Beamish 1974), *cottus perplexus* (Warren and Davis 1967), and Red Tilapia (Hepher *et al.* 1983). The dietary metabolizable energy required for maintenance of a fish of 1g is thus about double the specific routine metabolism. Therefore, in the present study, this value could be estimated as about 9.84 cal/g fish/day for Nile Tilapia and 23.74 cal/g fish/day for common carp (Table 5). In order to find the actual maintenance requirement of a fish, these values must be multiplied by the 0.8 power of the appropriate average weight of fish.

The calculated efficiencies are given in Table 6. From the calculations, there were considerable differences in efficiency between the two species of fish. It appears that the values of PEFG are higher in Nile Tilapia than in common carp at the two feeding levels.

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تأثير التغذية الشتوية على معدل النمو ، ومعدل التحويل الغذائي ، ومعدل الحياة فى أسماك البلطى النيلى وأسماك المبروك العادى

على عز الدين عبد الغنى

المعمل المركزى لبحوث الأسماك / مركز البحوث الزراعية - جيزة . مصر .

تهدف الدراسة الى التعرف على معدل التغذية المناسب لأسماك البلطى النيلى وكذلك أسماك المبروك العادى خلال موسم الشتاء فى مصر . معدلات التغذية التى تم إختبارها هى ثلاث معدلات (٢٪ ، ١٪ ، صفر٪ من وزن الأسماك الحية) . وأثبتت الدراسة قابلية الأسماك للتغذية خلال فصل الشتاء إلاّ أن معدل التحويل الغذائى للأسماك لم يكن جيداً . وأثبت البحث أن تغذية الأسماك خلال فصل الشتاء أدت الى حماية الأسماك من أن تفقد وزنها، ليس ذلك فقط بل أدت أيضاً الى أن تنمو الأسماك رغم أن معدلات النمو كانت بسيطة . وأثبتت الدراسة أن مربى الأسماك يمكنهم الإحتفاظ بالأسماك فى حالة جيده خلال موسم الشتاء بغرض تربيتها فى الموسم التالى للوصول بها الى أحجام تسويقية أكبر وذات أسعار جيدة وتناسب السوق المحلى .

وتم تقدير التمثيل الغذائى للأسماك Routine Metabolism فكان لأسماك البلطى ٦٤,٧ كيلو/كالورى/سمكة/يوم ولأسماك المبروك العادى ٢٤٧,٥ كيلو كالورى/سمكة/يوم . كذلك تم تقدير التمثيل الغذائى لوحدة الوزن من الأسماك (١ جم) Specific Routine Metabolism فكان ٩٢, كالورى/يوم لأسماك البلطى وكان ١١,٨٧ كالورى/يوم لأسماك المبروك العادى . كذلك تم تقدير الطاقة الغذائية اللازمة لحفظ حياة وحدة الوزن من الأسماك (١ جم) فكانت ٩,٨٤ كالورى/يوم للبلطى النيلى وكذلك ٢٢,٧٤ كالورى/يوم للمبروك العادى .